

Recovery of Platinum from Chloride Leaching Solution of Spent Catalysts by Solvent Extraction

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Platinum was recovered from the leaching liquor of spent petroleum catalyst by solvent extraction. Most of platinum in the spent catalyst was leached by using a mixture of HCl and H₂O₂ from the roasted spent catalyst. The effect of concentration of HCl/H₂O₂ in the solution, reaction temperature and pulp density was investigated. Complete extraction of Pt and Fe from the leaching liquor was obtained by Aliquat 336 at an O/A ratio of 1 in 2 stages. High-purity solutions containing Fe and Pt were obtained from the loaded Aliquat 336 by scrubbing with dilute HCl solution and stripping with HClO₄, respectively. Finally, HCl in the raffinate was regenerated by extraction with TEHA (Tri (2-ethylhexyl) amine) and then by stripping with water. The purity of HCl in the stripped solution was high enough to be reused in the leaching of spent catalysts. The optimum conditions in leaching, extraction and stripping together with the mass balance of the constituents of the spent catalysts in the whole process are reported. [doi:10.2320/matertrans.M20123200]

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Keywords: platinum, iron, spent catalyst, leaching, solvent extraction

1. Introduction

Platinum group metals (PGMs) has wide range of applications due to their peculiar physical and chemical properties.¹⁾ Among PGMs, platinum is used as an alloying agent for other metal products, such as fine wires, medical instruments, and jewelry. Platinum together with palladium and rhodium are the main active components of car catalytic converters.²⁾ Pt and Rh are indispensable in air-pollution control catalysts.³⁾ Platinum metal and PtO₂ are also widely used as catalyst in a variety of reactions in chemical and petroleum industry.^{4,5)}

The demand for PGMs in the manufacture of advanced materials with special function is increased with the development of industry. At the same time, considerable amounts of spent catalyst containing platinum and other precious metals are produced. The spent catalysts from automotive, chemical and petroleum industry are the secondary sources of the PGMs, in which the content of PGMs is about one thousand times of them in general platinum ores.^{6,7)} Since the cost for the production of PGMs from the naturally occurring ores is high, it is important to develop a process for the recovery of PGMs from these secondary resources.

Hydrometallurgical method has advantage in selectively recovering metals from secondary sources compared with the pyrometallurgical processing.⁸⁾ In hydrometallurgical method, PGMs are recovered by leaching with different lixivants from the spent catalysts,^{9–13)} and PGMs can be separated from the leaching solution by ion exchange or by solvent extraction.^{14–18)}

In this study, a hydrometallurgical process on the recovery of Pt from the spent petroleum catalyst was developed by leaching with hydrochloric acid and hydrogen peroxide followed by solvent extraction. An optimum leaching condition to maximize the dissolution of Pt from the spent catalysts was obtained from the experiments by varying

leaching conditions, such as roasting, the concentration of hydrochloric acid, the addition of oxidizing agent, the reaction temperature and pulp density. Large amount of Si in the leaching liquor was removed by filtration. Pt and hydrochloric acid was separated from the leaching solution. Fe was separated from the co-extracted organic containing Pt by scrubbing. Mass balance of the constituents in the spent catalysts was obtained. The purity and recovery percentage of Pt, Fe and HCl are reported.

2. Experimental

2.1 Catalyst

The spent catalyst pellets were crushed and homogenized by through mixing, and the particle size distribution was determined by standard sieve. The powders with a size distribution of 0.1–0.3 mm were employed in the leaching experiments. The chemical composition of the spent catalyst powder was determined by XRF and ICP-OES and the results are shown in Table 1.

In order to investigate the effect of roasting of the spent catalyst on the leaching of metals, the spent catalyst powders were roasted in a furnace in the temperature range from 700 to 900°C. During the roasting procedure, the temperature was increased at a rate of 10°C/min, and after the temperature was reached, the temperature was maintained constant for 5h. Then the roasted spent catalyst was cooled down in the furnace and was kept in a desiccator before experiments.

2.2 Leaching procedure

Leaching agents were prepared by diluting certain amount of acid or alkali in doubly distilled water. Reagent grades of

Table 1. The composition of the spent catalyst measured by XRF and ICP (Unit: mass%).

Element	Pt	Al	Si	Fe	Ni
	0.089	10.15	42	0.28	0.005

*Micro elements: S, Cl, K, Ca, Sr, Zr, Na.

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Metals in Wastes Karolina Wieszczycka, Bartosz Tylkowski, Katarzyna Staszak, 2018-07-23 Metals in Wastes is an excellent guide for scientists students engineers chemists and industrial chemists who are looking for knowledge of the main sources of metals in industrial wastes Metals are valuable materials that can be recycled again and again without degrading their properties The recycling of metals enables us to preserve natural resources while requiring less energy to process than the manufacture of new products using virgin raw materials A team of experts reviews the state of the art and provides the readers not only with a comprehensive in depth overview of the main composition of wastes but also discloses innovative methods which have been applied for recovery of critical and valuable metals in petrochemical industry rubber energy and automotive industries This know how could be considered as a useful reference tool for moving towards the zero waste economy Additionally the book describes the economic aspects of metals recovery from various sources This is essential for those already involved in the metals business and also for the financial investment and advisory community internationally

Tin and Silver Recovery from Coal Creek, AK J. L. Johnson, T. Parker, 1991 *Recovery of Platinum, Palladium, and Gold from Stillwater Complex Flotation Concentrate by a Roasting-leaching Procedure*, 1985 The Bureau of Mines devised a procedure for selectively extracting platinum group metals PGM and gold from Stillwater Complex flotation concentrate The Stillwater Complex is the only major U S PGM resource Development of a suitable extraction technique will contribute to its exploitation The concentrate was roasted at 1 050 C to convert host base metal sulfides to oxides and the PGM from sulfide minerals to their elemental states The roasted concentrate was preleached with dilute sulfuric acid to remove easily soluble gangue minerals After pre leaching the concentrate was slurried with 6M HCl and leached at ambient temperature and pressure with a strong oxidizing agent Hydrogen peroxide chlorine sodium hypochlorite nitric acid and a persulfate salt were the oxidants investigated The two stage leaching scheme extracted up to 97 pct of the platinum 92 pct of the palladium and 99 pct of the gold from the roasted concentrate The base metals were not solubilized and reported to the residue No attempt was made to devise a procedure to recover the copper and nickel because they comprise less than 5 pct of the value of the concentrate Viable techniques for recovering the precious metals from the pregnant solution were sulfide precipitation cementation with nickel or adsorption on activated carbon *Handbook of Non-ferrous Metallurgy Prepared by a Staff of Specialists* Donald Macy Liddell, 1926 **Literature and Patent References to Platinum Group Metals** International Nickel Company, 1930 *Metallurgy of Copper* Heinrich Oscar Hofman, 1924 **Catalog of Government Patents**, 1983

Journal of the Society of Chemical Industry Society of Chemical Industry (Great Britain), 1905 5th Southern Hemisphere Meeting on Mineral Technology, Buenos Aires, Argentina, 6-9 May 1997, 1998* *British Chemical and Physiological Abstracts*, 1930 **British Abstracts**, 1926 **Canadian Mining Journal**, 1924 *The Mining Magazine*, 1920 **Mineral Exploration, Mining, and Processing Patents, 1979** Oliver Sherman North, 1980-11 *New*

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